AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor, having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween, to detect an air-fuel ratio from an element current which flows through said sensor element at a level corresponding to a concentration of oxygen in an exhaust gas emitted from a combustion engine whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that

defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the exhaust gas starts, for each of levels of the oxygen concentration,

adjusts the applied voltage line such that the applied voltage line passes through the limiting current region set for each level of the oxygen concentration within the gas concentration detection range, and

controls the applied voltage according to the applied voltage line,

wherein a width of the limiting current region within the voltage level range varies due to the decomposition of the water in accordance with the oxygen concentration such that the width of the limiting current region is wide in a lean region of the air-fuel ratio while the limiting current region is narrow in a rich region of the air-fuel ratio,

wherein the width of the limiting current region in the lean region becomes larger as the air-fuel ratio is increased, [[and]]

wherein the second voltage point, at which the decomposition of the water starts, varies according to the air-fuel ratio, and

wherein the voltage level range of the limiting current region for each level of the oxygen concentration is changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element, a plurality of voltage level ranges of the limiting current region in a plurality of temperature conditions of the sensor element overlap with one another within a temperature-considered voltage level range for each level of the oxygen concentration, the voltage level range of the limiting current region at a minimum temperature in a temperature range actually attainable in a using environment of the sensor element and the voltage level range of the limiting current region at a maximum temperature in the temperature range overlap with each other within the temperature-considered voltage level range for each level of the oxygen concentration, and said applied voltage control

unit sets a single voltage line as the applied voltage line such that the single voltage line passes through the temperature-considered voltage level ranges of the limiting current regions for the levels of the oxygen concentration.

2. (Canceled)

3. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit specifies an upper limit point or a point in the vicinity of said upper limit point on the limiting current region set for a minimum level of the oxygen concentration in said gas concentration detection range and specifies a lower limit point or a point in the vicinity of said lower limit point on the limiting current region set for a maximum level of the oxygen concentration in said gas concentration detection range and sets the applied voltage line to pass through said points specified.

4. (Canceled)

5. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit devices said gas concentration detection range into a plurality of portions, and specifies, in each detection range portion, an upper limit point or a point in the vicinity of the upper limit point on the limiting current region set for a minimum level of the detection range portion specifies, in each detection range portion, a lower limit point or a point in the vicinity of

the lower limit point on the limiting current region set for a minimum level of the detection range portion and sets the applied voltage line to pass through said points specified.

6. (Canceled)

7. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit determines said limiting current regions on the condition that a variation of said element current is below a predetermined quantity, and sets said applied voltage line to pass through an intermediate point of each limiting current region.

8.-10. (Canceled)

11. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit sets a point at which said element current increases due to a residue of a reaction-hard component of unburned components contained in said exhaust gas as the second voltage point for each limiting current region.

12. (Canceled)

13. (Previously Presented) The apparatus according to claim 11, wherein said applied voltage control unit specifies an intermediate point between said first and second voltage points

for each limiting current region to cause the applied voltage line to pass through the intermediate points.

14.-16. (Canceled)

17. (Previously Presented) The apparatus according to claim 1, wherein, on voltage-current (V-I) coordinates representing the relationship between said applied voltage and said element current therein, said applied voltage control unit makes an inclination (I/V) of the applied voltage line smaller than an inclination (I/V) of a resistance governing region determined in accordance with a direct-current internal resistance of said sensor element.

18. (Canceled)

19. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit sets different applied voltage characteristics in a gas concentration detection range in which widths of the limiting current regions are approximately equal to each other and in a gas concentration detection range in which widths of the limiting current regions are different from each other.

20.-24. (Canceled)

25. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit adjusts the temperature-considered voltage level range of the limiting current region such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic of said sensor element after variation with time overlap with each other within the temperature-considered voltage level range, for each level of the oxygen concentration and sets the applied voltage line so as to pass through the temperature-considered voltage level range of the limiting current region for each level of the oxygen concentration.

26. (Canceled)

27. (Previously Presented) The apparatus according to claim 25, wherein said estimated output characteristic after the variation with time is an estimated output characteristic at a deterioration tolerance limit permitting a use of an output of said element current.

28. (Canceled)

29. (Previously Presented) The apparatus according to claim 1, wherein a sensor characteristic line indicating a relation between the applied voltage and the element current passes through the limiting current region, a resistance governing region placed in a voltage level

range lower than the first voltage point of the limiting current region and an outer region placed in a voltage level range higher than the second voltage point of the limiting current region for each level of the oxygen concentration, the sensor characteristic line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the inclination of the sensor characteristic line in the outer region and the inclination of the sensor characteristic line in the resistance governing region are larger than the inclination of the sensor characteristic line in the limiting current region for each level of the oxygen concentration, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on the voltage-current coordinates, an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage control unit sets the inclination of the applied voltage line in a first outer range placed outside the air-fuel ratio detection range on a rich side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the first outer range, and the applied voltage control unit sets the inclination of the applied voltage line in a second outer range placed outside the air-fuel ratio detection range on a lean side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the second outer range.

30. (Canceled)

31. (Previously Presented) The apparatus according to claim 29, further comprising an excess current detecting unit that detects said element current, and a logical unit that changes, when the element current detected by said excess current detecting unit is placed outside a range between a value of the element current at the lean limit and a value of the element current at the rich limit, the inclination of the applied voltage line in the first and second outer ranges to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range.

32. (Canceled)

33. (Previously Presented) The apparatus according to claim 31, further comprising a delay unit that delays a timing of the change of the inclination of the applied voltage line.

34. (Canceled)

35. (Previously Presented) The apparatus according to claim 1, wherein said applied voltage control unit has an applied voltage control circuit that feedback-controls the applied voltage on the basis of said element current and controls the applied voltage on the basis of the set applied voltage characteristic.

36. (Canceled)

37. (Previously Presented) The apparatus according to claim 35, wherein said applied voltage control circuit includes voltage change regulating means that regulates a change of the applied voltage.

38.-44. (Canceled)

45. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween, to detect an air-fuel ratio from an element current flows through said sensor element at a level corresponding to a concentration of oxygen in an exhaust gas emitted from a combustion engine whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that defines a characteristic of the applied voltage in advance,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the exhaust starts, for each of levels of the oxygen concentration,

adjusts an applied voltage line such that the applied voltage line passes through the limiting current region set for each level of the oxygen concentration within the gas concentration detection range, and

controls the applied voltage according to the applied voltage line,

wherein a width of the limiting current region within the voltage level range varies due to the decomposition of the water in accordance with the oxygen concentration such that the width of the limiting current region is wide in a lean region of the air-fuel ratio while the limiting current region is narrow in a rich region of the air-fuel ratio,

wherein the width of the limiting current region in the lean region becomes larger as the air-fuel ratio is increased, [[and]]

wherein the second voltage point, at which the decomposition of the water starts, varies according to the air-fuel ratio, and

wherein the voltage level range of the limiting current region for each level of the oxygen concentration is changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element, a plurality of voltage level ranges of the limiting current region in a plurality of temperature conditions of the sensor element overlap with one another within a temperature-considered voltage level range for each level of the oxygen concentration, the voltage level range of the limiting current region at a minimum temperature in a temperature range actually attainable in a using environment of the sensor element and the voltage level range of the limiting current region at a maximum temperature in the temperature range overlap with each other within the temperature-considered voltage level range for each level of the oxygen concentration, and said applied voltage control

unit sets a single voltage line as the applied voltage line such that the single voltage line passes through the temperature-considered voltage level ranges of the limiting current regions for the levels of the oxygen concentration.

46.-50. (Canceled)

51. (Previously Presented) The apparatus according to claim 1, wherein a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more

52.-58. (Canceled)

59. (Previously Presented) The apparatus according to claim 1, wherein a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

60.-66. (Canceled)

67. (Previously Presented) The apparatus according to claim 1, wherein a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.

68.-74. (Canceled)

75. (Currently Amended) A gas concentration detecting apparatus for use in a limit-current type gas concentration sensor having a sensor element including a solid electrolyte and a pair of electrodes interposing said solid electrolyte therebetween, to detect an air-fuel ratio from an element current which flows through said sensor element at a level corresponding to a concentration of oxygen in an exhaust gas emitted from a combustion engine whenever a voltage is applied to said sensor element, said apparatus comprising:

an element current detecting unit, connected to said electrodes of said sensor element, that detects the element current outputted from the sensor element within a gas concentration detection range set widely; and

an applied voltage control unit, connected to said electrodes of said sensor element, that

defines a characteristic of the applied voltage so as to linearly change the applied voltage with the element current detected in said detecting unit along an applied voltage line corresponding to the applied voltage characteristic,

sets a limiting current region within a voltage level range between a first voltage point, at which an electromotive force of said sensor element changing with an increase of the applied voltage starts to come into a balance with said applied voltage, and a second voltage point, at which a decomposition of water contained in the exhaust gas starts, for each of levels of the oxygen concentration, a voltage level range of the limiting current region for each level of the oxygen concentration being dependent on an output characteristic of the sensor element,

adjusts the applied voltage line such that the applied voltage line passes through the limiting current region set for each level of the oxygen concentration within the gas concentration detection range,

adjusts the voltage level range of the limiting current region to an adjusted voltage level range for each level of the oxygen concentration such that a voltage level range of the limiting current region determined by an initial output characteristic of said sensor element and a voltage level range of the limiting current region determined by an estimated output characteristic of said sensor element after variation with time overlap with each other within the adjusted voltage level range,

adjusts the applied voltage line so as to pass through the adjusted voltage level range of the limiting current region for each level of the oxygen concentration, and

controls the applied voltage according to the applied voltage line,

wherein a width of the limiting current region within the voltage level range varies due to the decomposition of the water in accordance with the oxygen concentration such that the width of the limiting current region is wide in a lean region of the air-fuel ratio while the limiting current region is narrow in a rich region of the air-fuel ratio,

wherein the width of the limiting current region in the lean region becomes larger as the air-fuel ratio is increased, [[and]]

wherein the second voltage point, at which the decomposition of the water starts, varies according to the air-fuel ratio, and

wherein the voltage level range of the limiting current region for each level of the oxygen concentration is changeable with a temperature of the sensor element due to a sensor output characteristic changing with the temperature of the sensor element, a plurality of voltage level ranges of the limiting current region in a plurality of temperature conditions of the sensor element overlap with one another within a temperature-considered voltage level range for each

level of the oxygen concentration, the voltage level range of the limiting current region at a minimum temperature in a temperature range actually attainable in a using environment of the sensor element and the voltage level range of the limiting current region at a maximum temperature in the temperature range overlap with each other within the temperature-considered voltage level range for each level of the oxygen concentration, and said applied voltage control unit sets a single voltage line as the applied voltage line such that the single voltage line passes through the temperature-considered voltage level ranges of the limiting current regions for the levels of the oxygen concentration.

76. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit specifies an upper limit point or a point in the vicinity of said upper limit point on the limiting current region set for a minimum level of the oxygen concentration in said gas concentration detection range and specifies a lower limit point or a point in the vicinity of said lower limit point on the limiting current region set for a maximum level of the oxygen concentration in said gas concentration detection range, and sets the applied voltage line to pass through said points specified.

77. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit devices said gas concentration detection range into a plurality of portions, and specifies, in each detection range portion, an upper limit point or a point in the vicinity of the upper limit point on the limiting current region set for a minimum level of the detection range portion specifies, in each detection range portion, a lower limit point or a point in the vicinity of

the lower limit point on the limiting current region set for a minimum level of the detection range portion, and sets the applied voltage line to pass through said points specified.

78. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit determines said limiting current regions on the condition that a variation of said element current is below a predetermined quantity, and sets said applied voltage line to pass through an intermediate point of each limiting current region.

79. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit sets a point at which said element current increases due to a residue of a reaction-hard component of unburned components contained in said exhaust gas as the second voltage point for each limiting current region.

80. (Previously Presented) The apparatus according to claim 79, wherein said applied voltage control unit specifies an intermediate point between said first and second voltage points for each limiting current region to cause the applied voltage line to pass through the intermediate points.

81. (Previously Presented) The apparatus according to claim 75, wherein, on voltage-current (V-I) coordinates representing the relationship between said applied voltage and said element current therein, said applied voltage control unit makes an inclination (I/V) of the

applied voltage line smaller than an inclination (I/V) of a resistance governing region determined in accordance with a direct-current internal resistance of said sensor element.

82. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit sets different applied voltage characteristics in a gas concentration detection range in which widths of the limiting current regions are approximately equal to each other and in a gas concentration detection range in which widths of the limiting current regions are different from each other.

83.-84.

85. (Previously Presented) The apparatus according to claim 75, wherein said estimated output characteristic after the variation with time is an estimated output characteristic at a deterioration tolerance limit permitting a use of an output of said element current.

86. (Previously Presented) The apparatus according to claim 75, wherein a sensor characteristic line indicating a relation between the applied voltage and the element current passes through the limiting current region, a resistance governing region placed in a voltage level range lower than the first voltage point of the limiting current region and an outer region placed in a voltage level range higher than the second voltage point of the limiting current region for each level of the oxygen concentration, the sensor characteristic line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current

coordinates defined by the applied voltage and the element current, the inclination of the sensor characteristic line in the outer region and the inclination of the sensor characteristic line in the resistance governing region are larger than the inclination of the sensor characteristic line in the limiting current region for each level of the oxygen concentration, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on the voltage-current coordinates, an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage control unit sets the inclination of the applied voltage line in a first outer range placed outside the air-fuel ratio detection range on a rich side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the first outer range, and the applied voltage control unit sets the inclination of the applied voltage line in a second outer range placed outside the air-fuel ratio detection range on a lean side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the second outer range.

87. (Previously Presented) The apparatus according to claim 86, further comprising an excess current detecting unit that detects said element current, and a logical unit that changes, when the element current detected by said excess current detecting unit is placed outside a range between a value of the element current at the lean limit and a value of the element current at the rich limit, the inclination of the applied voltage line in the first and second outer ranges to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range.

88. (Presently Presented) The apparatus according to claim 87, further comprising a delay unit that delays a timing of the change of the inclination of the applied voltage line.

89. (Previously Presented) The apparatus according to claim 75, wherein said applied voltage control unit has an applied voltage control circuit that feedback-controls the applied voltage on the basis of said element current and controls the applied voltage on the basis of the set applied voltage characteristic.

90. (Previously Presented) The apparatus according to claim 89, wherein said applied voltage control circuit includes voltage change regulating means that regulates a change of the applied voltage.

91. (Previously Presented) The apparatus according to claim 75, wherein a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more.

92. (Previously Presented) The apparatus according to claim 75, wherein a lean side limit of an air-fuel ratio detection range is set at the atmosphere.

93. (Previously Presented) The apparatus according to claim 75, wherein a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.

94.-98. (Canceled)

99. (Previously Presented) The apparatus according to claim 29, wherein the applied voltage control unit fixes the applied voltage at a constant value when the air-fuel ratio is in one of the first and second outer ranges.

100. (Previously Presented) The apparatus according to claim 1, wherein an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the applied voltage control unit divides the air-fuel ratio detection range into a plurality of range portions, and the applied voltage control unit individually sets the inclination of the applied voltage line at the range portions of the air-fuel ratio detection range.

101. (Previously Presented) The apparatus according to claim 1, wherein the width of the limiting current region is smallest at a rich limit in the air-fuel ratio while the width of the limiting current region is largest at a lean limit in the air-fuel ratio, and said applied voltage control unit sets the applied voltage line such that the applied voltage line passes through the limiting current region at the rich limit and the limiting current region at the lean limit.

102. (Previously Presented) The apparatus according to claim 1, wherein, as the air-fuel ratio is increased in the lean region, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

103. (Previously Presented) The apparatus according to claim 1, wherein, as the air-fuel ratio is increased, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

104.-113. (Canceled)

114. (Previously Presented) The apparatus according to claim 45, wherein the width of the limiting current region is smallest at a rich limit in the air-fuel ratio while the width of the limiting current region is largest at a lean limit in the air-fuel ratio, and said applied voltage control unit sets the applied voltage line such that the applied voltage line passes through the limiting current region at the rich limit and the limiting current region at the lean limit.

115. (Previously Presented) The apparatus according to claim 45, wherein, as the air-fuel ratio is increased in the lean region, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

116. (Previously Presented) The apparatus according to claim 45, wherein, as the air-fuel ratio is increased, the second voltage point of the limiting current region depending on the

decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

117.-118.

119. (Previously Presented) The apparatus according to claim 45, wherein a sensor characteristic line indicating a relation between the applied voltage and the element current passes through the limiting current region, a resistance governing region placed in a voltage level range lower than the first voltage point of the limiting current region and an outer region placed in a voltage level range higher than the second voltage point of the limiting current region for each level of the oxygen concentration, the sensor characteristic line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the inclination of the sensor characteristic line in the outer region and the inclination of the sensor characteristic line in the resistance governing region are larger than the inclination of the sensor characteristic line in the limiting current region for each level of the oxygen concentration, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on the voltage-current coordinates, an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage control unit sets the inclination of the applied voltage line in a first outer range placed outside the air-fuel ratio detection range on a rich side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor

characteristic line in the first outer range, and the applied voltage control unit sets the inclination of the applied voltage line in a second outer range placed outside the air-fuel ratio detection range on a lean side to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range so as to avoid intersection of the applied voltage line with the sensor characteristic line in the second outer range.

120. (Previously Presented) The apparatus according to claim 119, further comprising an excess current detecting unit that detects said element current, and a logical unit that changes, when the element current detected by said excess current detecting unit is placed outside a range between a value of the element current at the lean limit and a value of the element current at the rich limit, the inclination of the applied voltage line in the first and second outer ranges to be larger than the inclination of the applied voltage line in the air-fuel ratio detection range.

121. (Previously Presented) The apparatus according to claim 120, further comprising a delay unit that delays a timing of the change of the inclination of the applied voltage line.

122. (Previously Presented) The apparatus according to claim 119, wherein the applied voltage control unit fixes the applied voltage at a constant value when the air-fuel ratio is in one of the first and second outer ranges.

123. (Previously Presented) The apparatus according to claim 45, wherein an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel

ratio, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the applied voltage control unit divides the air-fuel ratio detection range into a plurality of range portions, and the applied voltage control unit individually sets the inclination of the applied voltage line at the range portions of the air-fuel ratio detection range.

124.-131. (Canceled)

132. (Previously Presented) The apparatus according to claim 86, wherein the applied voltage control unit fixes the applied voltage at a constant value when the air-fuel ratio is in one of the first and second outer ranges.

133. (Previously Presented) The apparatus according to claim 75, wherein an air-fuel ratio detection range is set between a lean limit of the air-fuel ratio and a rich limit of the air-fuel ratio, the applied voltage line has an inclination indicating a change of the element current with respect to the applied voltage on voltage-current coordinates defined by the applied voltage and the element current, the applied voltage control unit divides the air-fuel ratio detection range into a plurality of range portions, and the applied voltage control unit individually sets the inclination of the applied voltage line at the range portions of the air-fuel ratio detection range.

134. (Previously Presented) The apparatus according to claim 75, wherein the width of the limiting current region is smallest at a rich limit in the air-fuel ratio while the width of the

limiting current region is largest at a lean limit in the air-fuel ratio, and said applied voltage control unit sets the applied voltage line such that the applied voltage line passes through the limiting current region at the rich limit and the limiting current region at the lean limit.

135. (Previously Presented) The apparatus according to claim 75, wherein, as the air-fuel ratio is increased in the lean region, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

136. (Previously Presented) The apparatus according to claim 75, wherein, as the air-fuel ratio is increased, the second voltage point of the limiting current region depending on the decomposition of the water is shifted toward a higher voltage level so as to widen the limiting current region.

137.-144. (Canceled)

145. (Previously Presented) The apparatus according to claim 45, wherein a lean side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 20 or more.

146. (Canceled)

147. (Previously Presented) The apparatus according to claim 45, wherein a rich side limit of an air-fuel ratio detection range is set at an air-fuel ratio equal to 11 or less.

148. (Canceled)

149. (New) The apparatus according to claim 1, wherein said applied voltage control unit determines a first low-voltage side end point of the limiting current region at the minimum temperature of the sensor element for a minimum level of the oxygen concentration, a second low-voltage side end point of the limiting current region at the minimum temperature of the sensor element for a maximum level of the oxygen concentration, a first high-voltage side end point of the limiting current region at the maximum temperature of the sensor element for the minimum level of the oxygen concentration, a second high-voltage side end point of the limiting current region at the maximum temperature of the sensor element for the maximum level of the oxygen concentration, a first intermediate point placed between the first low-voltage side end point and the first high-voltage side end point for the minimum level of the oxygen concentration, and a second intermediate point placed between the second low-voltage side end point and the second high-voltage side end point for the maximum level of the oxygen concentration, and sets the single voltage line connecting the intermediate points as the applied voltage line.

150. (New) The apparatus according to claim 45, wherein said applied voltage control unit determines a first low-voltage side end point of the limiting current region at the minimum temperature of the sensor element for a minimum level of the oxygen concentration, a second

low-voltage side end point of the limiting current region at the minimum temperature of the sensor element for a maximum level of the oxygen concentration, a first high-voltage side end point of the limiting current region at the maximum temperature of the sensor element for the minimum level of the oxygen concentration, a second high-voltage side end point of the limiting current region at the maximum temperature of the sensor element for the maximum level of the oxygen concentration, a first intermediate point placed between the first low-voltage side end point and the first high-voltage side end point for the minimum level of the oxygen concentration, and a second intermediate point placed between the second low-voltage side end point and the second high-voltage side end point for the maximum level of the oxygen concentration, and sets the single voltage line connecting the intermediate points as the applied voltage line.

151. (New) The apparatus according to claim 75, wherein said applied voltage control unit determines a first low-voltage side end point of the limiting current region at the minimum temperature of the sensor element for a minimum level of the oxygen concentration, a second low-voltage side end point of the limiting current region at the minimum temperature of the sensor element for a maximum level of the oxygen concentration, a first high-voltage side end point of the limiting current region at the maximum temperature of the sensor element for the minimum level of the oxygen concentration, a second high-voltage side end point of the limiting current region at the maximum temperature of the sensor element for the maximum level of the oxygen concentration, a first intermediate point placed between the first low-voltage side end point and the first high-voltage side end point for the minimum level of the oxygen

concentration, and a second intermediate point placed between the second low-voltage side end point and the second high-voltage side end point for the maximum level of the oxygen concentration, and set the single voltage line connecting the intermediate points as the applied voltage line.